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IV. *A new Method for composing a natural History of Meteors communicated in a Letter to Dr. Jurin, R. S. & Coll. Med. Lond. Soc. By Mr. Isaac Greenwood, Professor of Mathematicks at Cambridge, New-England.*

*Honoured Sir,*

THIS Method in general is, that in Addition to such Observations as should be made on Land, there might be some Account taken of those also that were made at Sea ; which already are by far more numerous than what were ever made ashore, or indeed what can be expected thence for some Ages still to come. This Method occured to me, as I was looking over various *Journals of Voyages* in my Passage from *England*, in which I was not a little surpriz'd to find the following Particulars constantly observ'd.

*First*, There was a general Account of the *Weather* for every Day, during the Passage of the Ship on the Voyage, which tho' not quite so exact as the Observations of the same Kind that have been made on Land, particularly what were publish'd by the Rev. Mr. *Derham*, yet for all that I know, are sufficient for the Design. However, if there is any Defect in this Article, it is abundantly made up in another Column ; which is a far more exact Register of the *Direction of the Winds* than was ever kept *ashore*, being an Account thereof to every two Hours in the Day. This Article may perhaps

haps be of very great Importance ; since, as you observe, *Compertum habemus, ut quod maximè, subitas tempestatum commutationes Ventis præcipuè acceptas esse referendas.* As for the *Degree* or *Strength* of the Wind there are also sufficient *Data* in all Sea-Journals to determine it, as I shall particularly shew in the Sequel of this Letter. Lastly, there is a daily Account inserted of the *Latitude* and *Longitude* of the Ship, that there will be no Difficulty in computing what Part of the Globe each Observation belongs to.

And now since there is in the World a great Variety of these *Marine Observations* already made, (for in all Voyages whatsoever that have been perform'd for many Years past, it has been customary to keep an exact Journal of the aforesaid Articles,) I thought it might be no difficult Matter to collect therefrom the *History* of the *Winds*, and *Weather* in most Parts of the Ocean.

In order to this, I imagin'd that if the *Royal Societies* of *London* and *Paris* should encourage such a Design, they might easily procure *Extracts* from most of the Journals kept in their respective *Nations* : For certainly such Gentlemen as would be at the Pains to keep a constant *Diary* of the Weather, would not fail also to communicate such *Marine Observations*, as they should be able to obtain.

The *Seamen* likewise themselves, (among whom there are a considerable Number of such as have a Taste for *physical* Knowledge) as they are under a Kind of Necessity to observe exactly the *Winds*, &c. would not be backward in transmitting their Observations ; especially when they were informed of what Importance and Advantage it might be to themselves, and the Cause of *Navigation*.

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I proceeded further to think, that if the aforesaid *Societies* should judge it improper to be at so great an Expence as would be requisite in printing so many Extracts from such Journals as should be sent to them, that they might notwithstanding keep in *Manuscript* a Book of Tables of such *Marine Observations*, as they should think fit to collect therefrom; and that the *Secretaries* of the Society (who for the most Part are such Gentlemen as have in a particular Manner discover'd a generous Principle of promoting Natural Knowledge) should take Care, that all such Observations were transcribed in their proper Places.

The Form of these *Tables* I thought might be in the following Manner.

<i>January the First, 1726.</i>										
Longitude.			20.			21.			22.	
Latitude	H.	W.	D.	Weather.	W.	D.	Weather.	W.	D.	Weather.
	12.	N.	2.	Fair.						
	6.									
	12.	N b E	3.	Fair.						
30.	6.									
	12.							S b E	2.	Cloudy.
	6.								2.	Rain.
	12.							S	3.	Stm. of Rain.
31.	6.							S b E	2.	Rain.

In which the *Title* shews the *Year*, *Month*, and *Day*; the *horizontal Space* just below it, the *Longitudes*; the *vertical Space* without the double Lines, the *Latitudes*; that *within the double Lines*, the *Hour* of the Day; and the *horizontal spaces* under the *Longitudes*,

tudes, the *Wind*, its *Degree*, or *Strength*, and the *Weather*, which are accordingly mark'd with W.D. Weather.

In this Specimen I have noted every Degree of Latitude and Longitude, that the Work might be the more perfect. I have only taken Notice of Four Hours in the Day, *viz.* 12 at Noon, 6 in the Afternoon, 12 at Night, and 6 in the Morning. However, if there be requir'd a greater Exactness in this Article, it will be easy enough to frame Tables accordingly. I began the Hours with 12 at Noon, because all Journals are kept from that Period, the Marine Day being always counted from Noon to Noon. There may be other Columns inserted, as I shall mention in the Close of this Letter, tho' what I have already taken Notice of is sufficient to our present Design.

Of these Sort of Tables there must be at least Four Volumes; One for the *Atlantick Ocean*, which will be by far the largest of them all, and perhaps the most profitable, as most of the Trade of the World lies thereon; the second for the *Mediterranean*; and the others for the *German Sea* and *Baltick*. In Process of Time also, it may perhaps be thought worth the while to preserve such Observations as are made on the *Indian Sea*, and the *Pacific Ocean*.

I must acknowledge my self incapable of making a just Comparison between the Advantages and Inconveniencies attending such a *tabular Register* of the Winds and Weather, as I have propos'd; however, I will take the Liberty to mention one or two Things, by which you will see how the Matter appears unto me.

It must be confess'd, that the Work will be very much protracted, and require some considerable Appli-

cation and Care in extracting such Observations, as shall be of Use, from Journals. There will also be some Difficulty in procuring any considerable Number of such Journals ; and lastly, there is but a very small Number of Observations made, in Comparison to the Spaces that must be allow'd in the Tables for them, by which Means there must necessarily be a great Waste.

In Answer to these Objections, it may be said in general, that there will be much less Application and Care requir'd than in keeping a *Diary* of the Weather, &c. on the *Land*. By this Means also, there may be more Observations collected in a few Years, than can be expected from the other Method in some Ages ; and one Man may be able in a few Months, hereby to compile a larger History of the Weather, than what has hitherto been done by the united Observation of all such, as have undertaken this Province.

Tho' there might be some Difficulty as to *particular Persons* in procuring a great Number of Journals, it cannot be suppos'd, that so illustrious a Body of Men as the *Royal Societies* at *London* and *Paris*, should meet with the same. It is observable also, that in the *Royal Navy* of *Great-Britain*, the Masters of the *Mathematics* are oblig'd to keep such a Journal by an Act in the late Reign, on Board every Ship, which without Doubt might be easily obtained on this Occasion : Nor can we imagine any in the trading Interest would refuse a Thing, that tended so much to their own Advantage and Benefit.

It is true, there can be no Remedy for the many empty Spaces in the Tables, (if that Method be follow'd which I have propos'd ; ) however this will be look'd upon as a trifling Objection, by such as consult the Improvement

provement of *Natural Knowledge*, rather than the Waste of Paper.

I shall conclude these general Remarks, by observing, that as the History of the Winds and Weather is capable of a more speedy and expeditious Improvement from *Marine Observations* than from Diaries from the *Land*, so also it is capable hereby of a more large and extensive Improvement. Without Doubt it will require many Years before *Observatories* of the Weather, &c. will be erected at all the *Universities* and *Capital Towns* of the *Provinces, Shires, &c.* in *Europe*, (if ever such should be,) not to mention *Africa, Asia*, and *America*, from which little can be expected in this Affair; and yet upon that Supposition, how few would the Diaries be, in Comparison of the great Number of Journals that are annually kept at *Sea*? besides many Thousands that might perhaps be obtain'd, relating to the Course of the Winds and Weather, successively for many Years last past. It is beyond my Abilities, indeed, to calculate with any Exactness, how many Vessels there may be upon the Seas which I have named, in the Space of one Year, and consequently how many distinct Journals there are annually kept; however, if I may judge from the Trade of the little Town, where this Letter is dated, there must be many Thousands: For there are seldom less than eight or nine Hundred Voyages made to and from this Port in a Year. I shall only add in this Place, that the Method here propos'd seems to have the Advantage of the common Method heretofore used in composing the *Natural History of Meteors*; inasmuch as *that* requires a particular Application and Attention without any other Views and Advantages; whereas in *our Case* there is a Kind of Necessity

of making such Observations, in order to conduct a Ship safely thro' the Ocean, whether the philosophical Part of Mankind shall think fit to improve them in their Interest, or no : However, I would not be understood, by any Thing that has been said upon this Head, to derogate from the Design of observing *on Land*, for that likewise has many Advantages, that we can by no Means pretend to in the *New Method*.

I should protract my Letter to an unreasonable Length, did I enter professedly upon the particular Advantages and Benefits, that may accrue from such a *Tabular Register of Marine Observations*, as I have proposed. I shall mention therefore only two Things.

*First*, We may be able from this Method to define with a great deal of Exactness, the Bounds and Limits of all considerable Winds ; for as there are at all Times in the Year some Hundreds of Vessels at Sea, it is of the same Importance in our Case, as tho' there were so many distant Observatories there ; and that the Knowledge of these more *extensive* and *general Winds* would be of considerable Use, none will deny, that shall attentively consider it ; for hereby we may be able to judge, in what Place such a Wind has its Origin, how long a Time it continues, with what Velocity it moves, where its greatest Strength is, and how great a Part of the Earth it passes over. Perhaps also, in Process of Time, by this Means, we may arrive to so much Skill, as to judge with some considerable Certainty, from the Rise or Beginning of a Wind, what its Effect and Issue shall be ; which will be of as great Importance in *Navigation*, as any Thing still wanting. Again, from such *Marine Observations* of the more extensive and lasting Winds, it is not impossible, that we should be able to  
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make a probable Judgment of the Effect and Influence of the Wind upon the Weather ; which, for what Cause I know not, I have frequently observed at Sea, to change and alter, according as that doth.

*Secondly*, From collecting all such *Meteorological Observations* as are made at *Sea*, we may reasonably expect to come to the Knowledge of such Winds, as prevail most in particular *Latitudes*. Tho' the Wind is a very uncertain Meteor, there is no Doubt, but that in some Places, it has a very different Course from what it has in others. If I mistake not also, it has been frequently observed, in some particular Places, that the Course of the Wind in one Year has been much the same as in others ; and tho' there has been no particular Order or Exactness yet discover'd, yet the *prevalent Winds*, or the greater Number of Winds have been, in both Cases, according to the same Direction : In these Parts of the World it is remarkably so. We can't, indeed, expect to discover the *Reigning* or *Prevalent Winds* of such *Latitudes*, as are very distant from the *Tropicks*, by as easy an Observation, as the *Trade-Winds* and *Monsoons*, which are in the *Torrid Zone*, were first found out. However as it has been after many Observations, that the Course of those *Fix'd Winds* was determin'd, we may also hope, that Time and Industry may bring us to a much better Knowledge than what we have at present, of these which are more *Variable*. I need not say of how much Importance it would be to the Trading Part of the World, were we able to define the more frequent and reigning Winds of every Climate ; for as the Probability of Voyages might then be calculated in the same Manner as that of other Chances, the Sailor might then better know

know how to order his Course so, as to arrive with the most probable Dispatch to his Port.

It may not be impossible also, from a protracted Series of *Sea Observations*, not only to know the general Course of the Winds in every Climate in the whole Year, but also to make a very probable Judgment of the reigning Winds of the several *Seasons of the Year*, and perhaps of *every Month* too : Which if it could once be obtained, we should have nothing more uncertain in *Navigation*, than that it was a *Doctrine of Chances*, which might be mathematically calculated.

I shall mention under this Head but one thing more, which we may with all the Probability imaginable expect to arrive to, *viz.* the particular Seasons, Signs, and Places of the *Tornados* and *Hurricanes*. The Effect of these are in many Cases so fatal, that they call for all our Skill and Observation : And could the History hereof be so successively known, as that we might be able to draw any certain Conclusions from it relating hereunto, it might perhaps be a sufficient Recompence for all the Care, that is requir'd, in the whole Collection of *Marine Observations*.

I might add in common to the two foregoing Heads, that the *Marine Observations* have much the Advantage of such as are made *on Land*, (which notwithstanding are of very great Service,) inasmuch as they are not obnoxious to any external Accidents, as these are ; the Winds ashore being frequently interrupted in their Course, and often diverted therefrom, by intervening Mountains, Vallies or Promontories.

Were I allowed to reckon among the Advantages of this *New Method* of observing on the Winds and Weather, those incidental Observations, that might be found  
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in *Journals*, of general Benefit to Mankind, they are perhaps alone sufficient to engage us in the Work. I shall only hint here, that if it should be thought proper to practice our Design, it may perhaps be worth the while to insert into the *Meteorological Tables*, such Observations as relate to the *Variation of the Compass* and *Currents*; the true Knowledge of which would be of no inconsiderable Service to *Navigation*.

If likewise there was a Column left for such remarkable Accidents as did occur, it might not be amiss; particularly, any uncommon Discoveries of Lands, Rocks, or Soundings; excessive Thunder and Lightning, &c. Luminous Appearances in the Sky; what Remarks may be found relating to the Water-Spout, which tho' perhaps one of the most curious Phenomena of Nature, is as little known as any whatsoever; submarine *Hiatus* or Whirlpools, if any such there be; and lastly, any extraordinary Rendezvous of Fish, &c. that are used in the Affairs of Life, not to mention such Descriptions, as may relate to Matters of meer Speculation and Curiosity.

But these Sort of accidental Advantages, in such a Collection of Journals of Voyages, as is necessary to our Design, are too numerous to be insisted on: I shall therefore only add one more, which is the great Improvement there would hereby be given to *Geography*, a Science of the greatest Use and Importance in the Affairs of Life. Not only all *Hydrographical Charts* might be by this Means corrected, and brought to the Truth, which is of so much Concern, that the Lives of a great Part of such as go to Sea depend upon it; but also, the Distances and Situation of all *Sea-Ports*, and many other Things, which are uncertain, or wanting in that Science, determin'd with the greatest Exactness.

In a Word, *Geography* may, by such an Expedient, arrive, in a very expeditious Manner, to as great a Degree of Perfection, as it is capable of.

I shall have finish'd my Design in this Letter, when I have taken Notice of the Method of determining the Degree and Strength of the Wind, from such *Data* relating thereunto, as are to be found in Sea-Journals; which in general is, from observing how many *Knots* the Vessel goes at the Time of Observation; which is always inserted in the *Day-Book* or *Journal*; or, in other Words, what *Velocity* she then has; for the Strength of the Wind may, with Exactness enough, in this Affair, be judg'd of from the Effect it produces, or the Motion it communicates to the Ship. It is true, there will be some considerable Difference in this Respect, arising from the Shape and Burthen of the Vessel: However, as we do not expect a mathematical Exactness in this Article, after a little Use and Experience, together with comparing the greatest Velocities of different Ships together, a Person may seldom fail of judging of the Strength of the Wind, at least to a fourth Part; that is, if according to the Method you propose in your *Invitatio ad Observationes Meteorologicas*, the greatest Winds be express'd by 4, and the lightest by *Unity*.

In *Oblique Winds*, the Strength or Degree thereof will not be directly proportional to the Velocity of the Vessel, but must be corrected a little; however, there will be no Difficulty in this Matter. For such as are acquainted with the Method of resolving *Oblique Powers* into *Direct ones*, may easily compose a Table of *Proportional Parts* suited thereunto. I did intend to have inserted such a Table; but I am afraid I have  
already

already trespass'd in the Length of this Epistle, and shall therefore only add, at present, that I am,

*With the utmost Sincerity and Respect,*

*Your most obedient, and*

*devoted humble Servant,*

Isaac Greenwood.

### P O S T S C R I P T.

SINCE my writing the foregoing, I have thought on a *Method* of keeping the *Meteorological Tables* therein propos'd, whereby the Work will be very much contracted. This is, instead of constructing the *Tables* according to the *Oceans* whereon the most considerable Trade of the World lies, to frame them only according to the *Route* of the most common *Voyages* on those *Seas*. Thus, may one of the *Tables* be confin'd to that Part of the *Atlantick Ocean*, which such Ships generally pass over, that Trade between *Great-Britain* and the *West Indies*; another *Table* for those Parts of the *Ocean*, that lie in the Passage of such Ships as are engaged in the *Mediterranean*, or *Turkey Trade*; to which may be added a *Table* for the *African*, and *India Commerce*. Another *Table* may be framed to that Part of the *Ocean*, that lies between the *Northern Provinces* in *America* and the *West Indies*; as also one for the Ships that pass between *New-England*, and

H h h

*New-*

*New-York* and *Britain*, which on the Northern Part may be made so wide as to take in the *Newfoundland* Trade, &c. But I shall mention no more Particulars; for in the same Manner it will be easy to construct *Tables* to all those considerable Parts of the World, to which Voyages are perform'd.

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V. *Some Observations towards composing a Natural History of Mines and Metals, communicated in a Letter to Dr. Rutty, S. R. Secr. & Coll. Med. Lond. Soc. By Dr. Frank Nicholls, Professor of Anatomy at Oxford.*

*Dear Sir,*

IN Obedience to your Commands, I here send you the Particulars of what I observ'd during a Year's Stay in the Western Part of *Cornwall*, concerning *Mines*, &c.

*Mines in general* are Veins or Cavities within the Earth, whose Sides receding from, or approaching nearer to each other, make them of unequal Breadths in different Places; sometimes forming large Spaces, which are call'd Holes. They are fill'd with Substances, which, whether metallick, or of any other Nature, are term'd the *Loads*. When the Substances forming these Loads are reducible to Metal, the Loads are by the Miners said to be *alive*; otherwise they are term'd *dead Loads*.

In